A New Device for Non-Invasive Measurements of Intracranial Pressure (ICP) in Newborns

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With increased survival of low birth weight and birth asphyxiated infants, the problem of intracranial hemorrhage has grown proportionally. Some investigators report as high as 30 % incidence of subependymal and intraventricular hemorrhage in preterm infants. Because of the significance of this problem, methods for non-invasive assessment of intracranial status of these infants are actively being sought. It is hypothesized that monitoring intracranial pressure may give insights regarding the causative factors of intracranial hemorrhage.

Our laboratory has developed a new transducer for the measurement of ICP across the fontanel of newborns (Fig. 1).

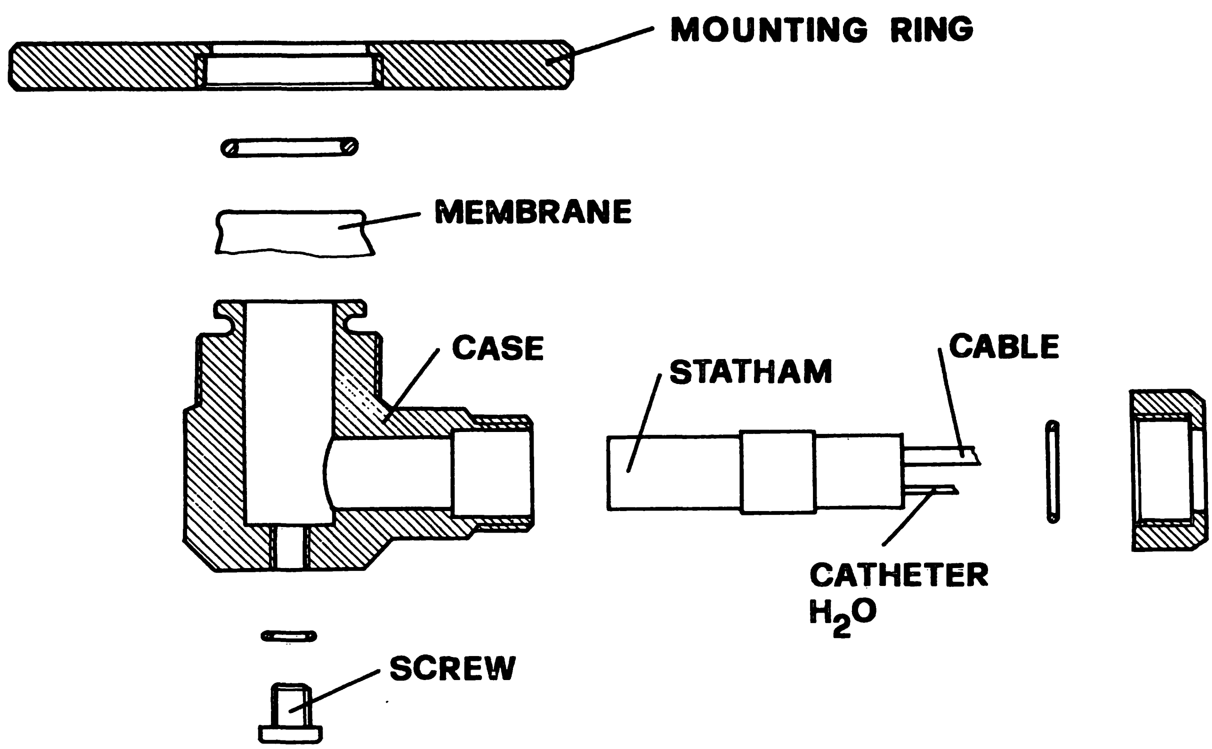

Fig. 1: Schematic Diagram of ICP Transducer

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A statham pressure transducer is fitted to a small plastic case. A pressure sensitive silicone membrane is applied to the surface of the case with an O-ring and a plastic mounting ring is applied. The encasement is filled with water through a polyvinyl catheter and the system is closed to air with a small screw and O-ring. The Statham transducer is connected to a pressure analyzer. The system is calibrated by varying the height of the column of water in the catheter above the transducer. For our studies, we calibrated at 0 and 50 cm. H_2O. In addition, we have devised a safe and effective method for applying the transducer to the fontanel. Four velcro bands are connected to the mounting ring and an attachment band is wrapped about the infant's head.

We have studied 130 infants with this technique. The ICP measurements in 103 healthy term infants studied on the first day of life show a mean of 10.7 cm. H_2O (SD=3.8), 5 healthy preterm infants had a mean of 9.1 cm H_2O (SD=5.4), 7 sick term infants had a mean of 15.6 cm. H_2O (SD=5.9) and 15 sick preterm infants had a mean of 14.1 cm H_2O (SD=6.3). These values are consistent with those reported during direct ICP measurements (1).

We have succeeded in monitoring 20 healthy term infants during the first hours, the first 2-3 days, and at about 1 week. 15 of the 20 infants showed a significant increase in ICP during days 2-3. The mechanism of this rise is uncertain but it is of interest because of the coincidental peak incidence of intracranial hemorrhage during these days. Three of the 20 infants had markedly elevated ICP values. All three had histories of birth asphyxia. One had suffered a prolonged and difficult labor, had had late decelerations and was delivered by vacuum extraction. He developed seizures at 2 days of life following the recording of an ICP of 27 cm. H_2O. Two infants were delivered by cesarean section because of fetal distress and pHs were low. ICPs of 19 and 24 cm H_2O were measured. Some of the lowest values were measured in infants following delivery by repeat cesarean section with no evidence of asphyxia. We have measured two sets of twins in the first hours, days and at 1 week of life. In both pairs, twin B was significantly asphyxiated with a lower Apgar and pH than twin A. ICP was significantly higher in the asphyxiated twin in both sets and the difference was greatest during the second and third day than before or after. Further investigations of the effect of labor and delivery on ICP must be made.

We have now incorporated ICP monitoring into our polygraphic monitoring of preterm infants. In these infants, we continously monitor heart rate, thoracic impedance, $tcPo_2$, ICP and respiratory rate. Fig. 2 shows the typical tracing of a healthy preterm infant. Periodic breathing is accompanied by minor fluctuations in $tcPo_2$. ICP is 5-8 cm. H_2O fluctuating with respiration and with heart rate. This is the typical level and degree of variability seen in preterm infants without cardiorespiratory compromise. In contrast, Fig. 3 shows the typical pattern of the sick preterm infant. Heart rate is high, respiratory pattern is irregular with periods of ineffective ventilation, $tcPo_2$ is low and demonstrates greater variability and ICP is abnormally high with great fluctuations. The role of these large changes, from 5 to 45 cm H_2O, in stressing the cerebral vessels and causing bleeding must be investigated. Some causes of acute increases in ICP in these infants have been identified in our studies.

We conclude that ICP monitoring with the modified Statham transducer developed in our laboratory is useful and reliable. It detects acute changes

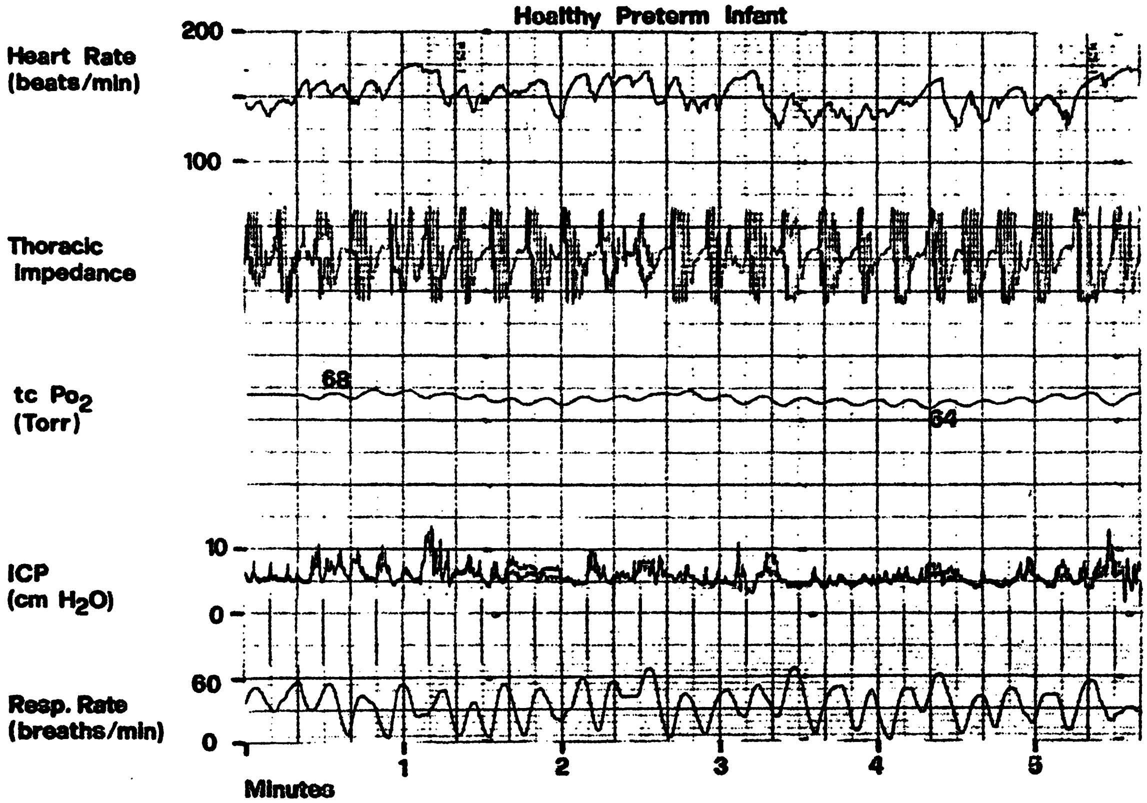

Fig. 2: Typical Polygraphic Tracing from a Healthy Preterm Infant

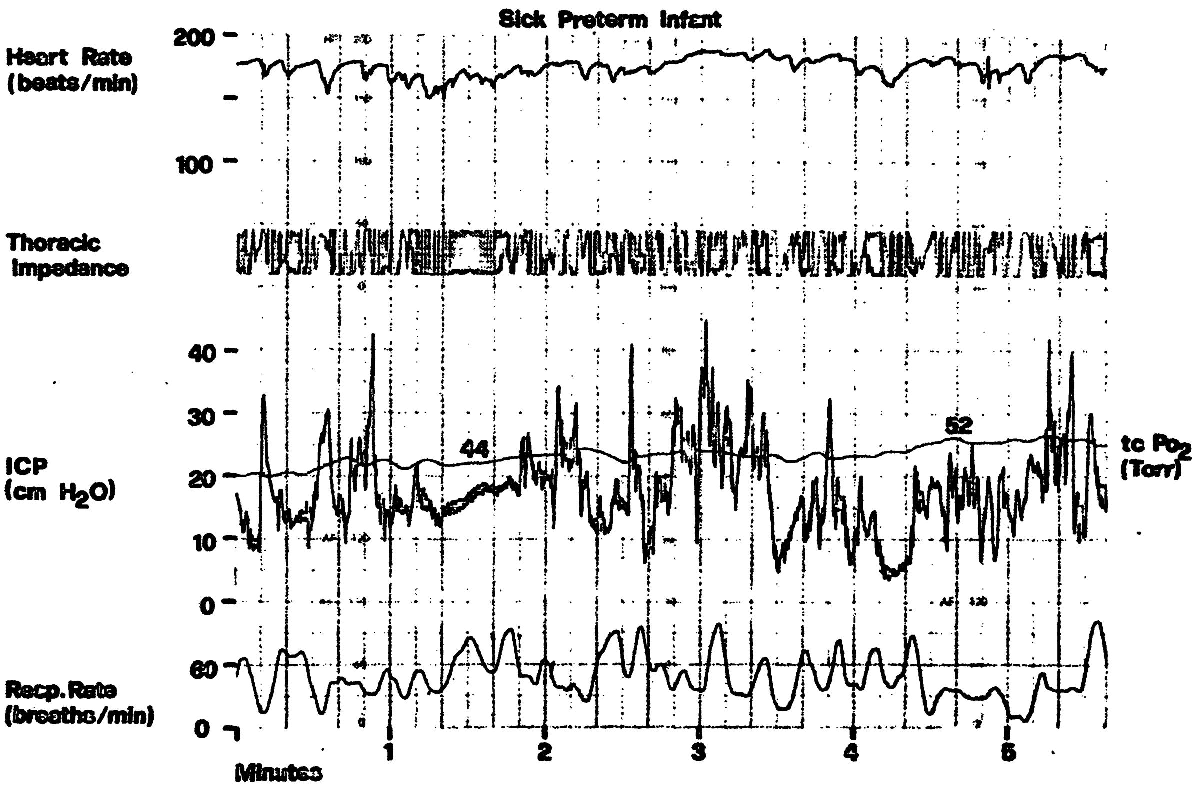

Fig.3: Typical Polygraphic Tracing from a Sick Preterm Infant

in intracranial pressure and provides a non-invasive technique for investigating the causes of high pressure in infants. Preliminary data suggests that ICP is highest during days 2-3 in many infants. It is higher and the rise is greater following difficult deliveries. Both term and preterm sick infants demonstrate higher and more variable ICP than healthy infants of the same gestation. Finally, respiratory disturbances such as IRDS, apnea, ineffective ventilation, fighting the respirator, crying, breath holding, and airways obstruction can cause marked fluctuations in ICP. The role of these factors in the development of intracranial hemorrhage must be further investigated.

Reference: Vidyasagar, D., Raju TNK
A simple non-invasive technique of measuring intracranial pressure in the newborn Pediatrics 59 (suppl.),957, 1977

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